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Voyager's New Neptunian Moons
Pegasus—Winged Workhorse
Columbia Flies DOD Mission

THIS ISSUE

President George Bush has issued the call for a sustained and systematic manned exploration of the solar system, requiring the newly formed National Space Council under the leadership of Vice President Dan Quail to provide planning details. NASA's input will be managed by JSC's Aaron Cohen. The President's mandate and his remembrance of the Apollo 11 Lunar mission is covered on the facing page.

"Inside NASA" looks at the Presidential Executive Exchange program and what it does for NASA and Industry.

Mum was the word as Space Shuttle Columbia returned to flight with a classified DOD mission. A successful homecoming was photographically captured on page six.

Voyager 2 brings home the astronomical bacon on its rush past Neptune. New Neptunian moons are highlighted in this issue.

Mythology's winged horse, Pegasus, lends its name to a new, winged, air-launched space booster. *NASA Activities'* centerfold takes a look at the new small payload workhorse, its first rider and NASA contributions.

"Center Highlights" provides an illuminating look at **blood protein studies at Marshall, a new robotics facility at Goddard** and investigation of the **effects of rain on aircraft lift performance being conducted at Langley.**

"NASA News Capsules" covers a host of new studies and grants for Space Shuttle, Space Station and Hubble Telescope missions, as well as University advanced engineering grants.

Next Month:

Voyager: Window on the Outer Planets.

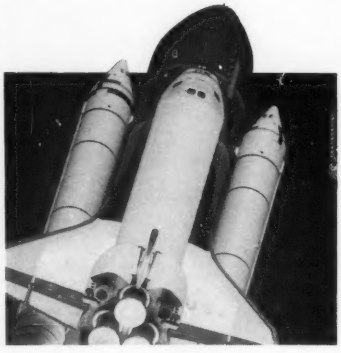
CONTENTS

President Charts U.S. Space Course, Remembers Moon Landing 3
Cohen to Lead NASA Preparation for New Civil Space Goals 4
"Inside NASA": A Look at Presidential Executive Exchange 5
Columbia Flies After Upgrade Modifications, a DOD Mission 6

Agency Highlights
Voyager Discovers New Neptunian Moons. 7
Pegasus — The Winged Workhorse 8

Center Highlights
MSFC Scientists Identify Molecular Structure of Blood Protein .. 11
Goddard Opens Space Robotics Facility 12
Langley Studies Effects of Heavy Rain on Aircraft Performance .. 12

Departments
Q&A: School Days for Astronauts 13
NASA News Capsules 14
Human Factors 15



About the Cover

Columbia blasts skyward in its first flight in three-and-a-half years. The STS-28 mission lifted off Kennedy Space Center's launch pad 39-B after clearing of early morning mists. Reflections off the wing surfaces obscure the ensign and national designation while Columbia's three main engines develop shock cones during ascent.

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President Bush Charts U.S. Space Course — Remembers Moon Landing Contributions

(The following are selected remarks of the President upon occasion of the celebration of the 20th anniversary of the first Apollo Moon landing, July 20, 1989 at the National Air and Space Museum.)

"To seize this opportunity...I'm proposing a long-range, continuing commitment:
...for the 1990's, Space Station Freedom...
...for the new century — back to the moon. Back to the future. And this time back to stay...
...and then a journey into tomorrow...a mission to Mars."

Project Apollo. The first men on the Moon. Some called it quixotic, impossible — had never been done. But America dreamed it. And America did it. And it began on July 16th, 1969. The sun rose a second time that morning as the awesome fireball of the Saturn V lifted these three pioneers beyond the clouds. A crowd of one million — including half of the United States Congress — held its breath as the Earth shook beneath their feet — and our view of the heavens was changed forevermore.

President Bush charts new space course on the occasion of the 20th anniversary of the first Lunar landing, July 20, 1989. The Apollo 11 Moon landing crew was also in attendance at the National Air and Space Museum celebration site.

... The landing itself was harrowing. Alarms flashed — and a computer overload threatened to halt the mission while Eagle dangled thousands of feet above the Moon. Armstrong seized manual control to avoid a huge crater strewn with boulders. With new alarms signalling a loss of fuel — and the view now blocked by lunar dust — Mission Control began the countdown for a mandatory abort.

America — indeed the whole world — listened: a lump in our throat and a prayer on our lips. And only 20 seconds of fuel remained. And then out of the static came the words: "Houston, Tranquility Base here. The Eagle has landed."

Within one lifetime, the human race had traveled from the dunes of Kitty Hawk to the dust of another world. Apollo is a monument to our nation's unparalleled ability to respond swiftly and successfully to a clearly stated challenge — and to America's willingness to take great risks for great rewards.

We had a challenge. We set a goal. And we achieved it.

... Apollo astronauts left more than flags and footprints on the Moon. They also left some unfinished business. For even 20 years ago, we recognized that America's ultimate goal was not simply to go there and go back — but to go there and go on.

Mike Collins said it best: "the Moon is not a destination — it is a direction."

... The time has come to look beyond brief encounters. We must commit ourselves a new to a sustained program of manned exploration of the solar system — and yes — the permanent exploration of the solar system — and yes —

continued on next page

Mars morning: It is just after sunrise in the Valles Marineris and early morning clouds can be seen on the canyon floor four miles below in this illustration.

the permanent settlement of space. We must commit ourselves to a future where Americans and citizens of all nations will live and work in space.

And today, yes, we are, the U.S. is the richest nation on Earth — with the most powerful economy in the world. And our goal is nothing less than establish the United States as the preeminent space faring nation

From the voyages of Columbus — to the Oregon Trail — to the journey to the Moon itself — history proves that we have never lost by pressing the limits of our frontiers.

... In 1961, it took a crisis — the space race — to speed things up. Today we don't have a crisis. We have an opportunity.

To seize this opportunity, I'm not proposing a 10-year plan like Apollo. I'm preparing a long-range, continuing commitment.

First, for the coming decade — for the 1990's — Space Station Freedom — our critical next step in all our space endeavors.

And next — for the new century — back to the Moon. Back to the future. And this time back to stay.

And then — a journey into tomorrow — a journey to another planet — a manned mission to Mars.

"Each mission should — and will lay the groundwork for the next. And the pathway to the stars begins as it did 20 years ago, with you — the American people. And it continues just up the street there — to the United States Congress — where the future of the Space Station — and our future as a spacefaring nation — will be decided.

And yes, we're at a crossroads. Hard decisions must be made now as we prepare to enter the next century.

As William Jennings Bryan said — just before the last turn of the century: "Destiny is not a matter of chance — it is a matter of choice. It is not a thing to be waited for — it is a thing to be achieved."

And to those who may shirk from the challenges ahead — or who doubt our chances of success — let me say this:

"To this day, the only footprints on the Moon are American footprints. The only flag on the Moon is an American Flag. And the know-how that accomplished these feats is American know-how. What Americans dream — Americans can do.

"...And today I'm asking my right hand man, our able Vice President, Dan Quayle, to lead the National Space Council in determining specifically what's needed for the next round of exploration — the necessary money, manpower, and material — the feasibility of international cooperation — and develop realistic timetables, milestones along the way. The Space Council will report back to me as soon as possible with concrete recommendations to chart a new and continuing course to the Moon and Mars and beyond.

Why the Moon? Why Mars? Because it is humanity's destiny to strive, to seek, to find. And because it is America's destiny to lead. ... ■

JSC's Cohen to Lead NASA Preparation for New Civil Space Goals

NASA Administrator Richard H. Truly has requested Aaron Cohen, director of Johnson Space Center, to lead agency activities in response to the national goal of human exploration of the moon and the planet Mars, announced by President Bush. Cohen will be temporarily assigned to NASA Headquarters in Washington for the next few months. Lead by Vice President Quayle, the National Space Council's recommendation to the President will be influenced markedly by the NASA effort Cohen will lead.

INSIDE NASA
Presidential Exchange Executives

Exchanging the grey flannel of business for the pinstripe of government can lead to benefits in the way government agencies are managed and a corporate understanding of how government works.

This is the kind of cooperative interchange being fostered by The President's Commission on Executive Exchange. The goal is to provide a forum for the effective interchange of ideas, innovation and understanding between business and government.

NASA benefits from the differing backgrounds and experience brought by private sector executives to its management and the individual executives benefit from the enrichment brought by new dimensions brought by governmental work.

The Presidential Exchange Executives serving this year at NASA Headquarters are Dr. Franklin D. Lemkey, Senior Consulting Scientist from United Technologies Corporation, Hartford, Conn. and Michael H. Starks, Manager of Information for the IBM Corporation, Armonk, New York.

NASA Activities asked our exchange executives about the program and their involvement in it:

NASA Activities: **Dr.Lemkey, in a day when many NASA professionals are feeling pressured to leave the agency, what motivates the competitive corporate executive to leave his job for a year and come to NASA?**

(Lemkey outlined his career with UTC and how he came into a role of consulting scientist, becoming a "window" to new technologies and influencing students to join UTC. Continuing in this role he served on various committees advising NASA.)

Franklin D. Lemkey

Michael H. Starks

Lemkey: ... It's like an investment...I was too young for the Korean (war), too old for Viet Nam—I figured, "Hey this could be my military service with a pin...When you go into government service you always expect a difference in your living style. That's not bad. So I rationalized on the basis of: I needed to do it, this is the timing, ...that this was the year of decisions...Space Station, obviously, was coming to a crisis point and it is almost every year but this was not a biggy....If you're going to do it this was the year to do it, so this is why I am here. And I've not been disappointed....

NASA Activities: **Mr. Starks, what were your objectives in coming to NASA?**

Starks: The objectives were to be exposed to and, if possible, to participate in policy making to see how decisions are made at the top levels of government. And to make a contribution in terms of my skills which are in communications...The office (Planning) need was for someone with a communications background who could help to communicate the progress and the results of the strategic planning effort to others in the agency and help communicate it —help prepare the materials — outside the agency...what I get out of it is exposure to and involvement in the actual process of developing that strategic planning.

NASA Activities: **Have there been any surprises so far?**

Lemkey: I've not been disappointed except for the fact that I've thought that NASA would be full up with visionaries and I'm finding that the visionaries—I'm still looking for them, and I'm finding really good journeyman workers. And I mean really dedicated people...I told these people that if they're working over 40 hours they must be doing something wrong...that I was going to straighten that out. Well, now I'm working 60 hours, not quite, but certainly 50 hours a week....

Mr. Starks: ...NASA seems to me to be the IBM of the Federal government in all the positive senses. There's a culturally embedded commitment to quality and doing the job right and to solving problems. The quality of people in NASA is very, very impressive....■

Columbia Flies After Upgrade Modifications STS-28 is a DOD Mission

Mission Hiatus Improves Capabilities

About 258 modifications have been made to Columbia since it last flew in Jan. 1986 on mission 61-C, including the list of critical return-to-flight vehicle improvements and about 16 that are unique to Columbia.

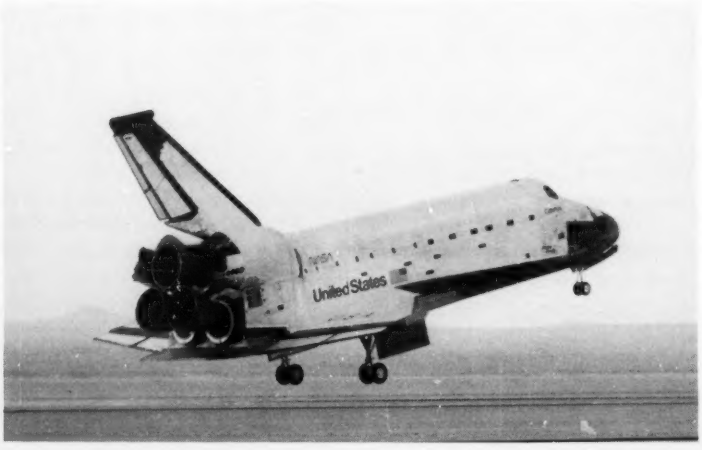
The return-to-flight modifications made to Columbia now bring the vehicle up to par with the other two orbiters, Discovery and Atlantis. These extensive improvements include the crew escape system, a latch to hold the 17-inch disconnect valve between the orbiter and external tank open during powered flight, wiring improvements and new thrusters in the forward reaction control system and orbital maneuvering system pods to prevent a burn through of the thrusters.

To decrease brake wear, the axles were stiffened on the landing gear. Instrumentation has been added to monitor the tire pressure once the landing gear doors are closed.

Larger protective tiles have been installed in the elevon leading edge and wing trailing edges to improve flight durability and decrease turnaround maintenance. Technicians have replaced over 2,300 small white diced tiles with thermal protective blankets like those on the other two ships. In addition, Columbia features the reinforced carbon-carbon "chin panel", which replaces about 40 tiles between the nose cap and nose landing gear doors.

Columbia features more instrumentation than the other two ships for research and development.

continued on page 13



(Below) Space Shuttle Columbia lands at 6:37 a.m. PDT August 13, 1989, at Edwards, Calif. Ground crews at Dryden Flight Research Facility began preparing Columbia for its ferry back to Kenndy Space Center soon after landing. The Shuttle blasted to orbit from KSC at 8:37 a.m. EDT, August 8, on a classified, Department of Defense mission. The newly refitted Columbia was crewed by astronauts (above, from left) Richard (Dick) N. Richards, former Navy test pilot; Mission Specialists James C. Adamson, former Army test pilot; David C. Leestma, STS 41-G veteran; Mark N. Brown, former USAF fighter pilot assigned to the cancelled STS-61N DOD mission; and Mission Commander Brewster H. Shaw, veteran STS-9 pilot and STS 61-B commander. Crew is shown in JSC's Shuttle Mission Simulator.

AGENCY HIGHLIGHTS

Voyager Discovers New Neptunian Moons

By Mary Beth Murrill, JPL

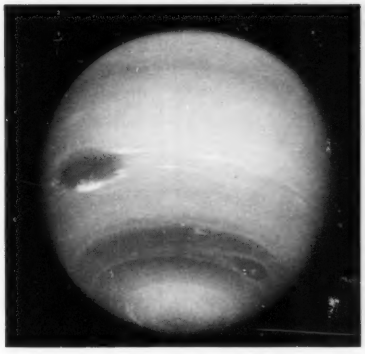
Images from NASA's Voyager 2 spacecraft have revealed four newly discovered moons in orbit around Neptune, according to Voyager imaging team scientists.

The discovery brings to six the number of moons known to exist around the blue planet.

The spacecraft, launched in 1977, has explored Jupiter, Saturn and Uranus and came within 3,000 miles of Neptune's cloud tops.

Many more moons may be found, according to Voyager scientists.

1989 N1, initially seen in Voyager 2 images transmitted to Earth in mid-June, is in a nearly circular orbit 57,600 miles from the planet's cloud tops and is 125 miles to 400 miles in diameter.



Neptune at less than 6 million miles.

The following three Neptunian satellites, designated 1989 N2, 1989 N3 and 1989 N4, were tracked as candidate moons in images returned by the spacecraft over a 5-day period. When the objects were found to follow predicted orbits, Voyager imaging scientists were able to confirm them as moons of Neptune. Their temporary names designate the order in which they were discovered.

Like 1989 N1, the three new moons occupy nearly circular and equatorial orbits around the planet. All move in prograde orbits (in the same direction the planet rotates), making the large moon Triton, which occupies a retrograde orbit, even more of an oddity in the Neptune system.

The innermost of the new moons is 1989 N3, which orbits at a distance of about 32,300 miles from the center of the planet or about 17,000 miles from Neptune's cloud tops. It makes one complete orbit of Neptune every 8 hours, 10 minutes.

Next is 1989 N4, orbiting about 38,000 miles from the planet's center or about 23,300 miles from the cloud tops. It orbits the planet every 10 hours, 20 minutes.

The outermost is 1989 N2, orbiting at about 45,400 miles from Neptune's center or about 30,000 miles from the cloud tops. It completes an orbit every 13 hours, 30 minutes.

The three new moons exist in the region where partial Neptunian rings or "ring arcs" are thought to exist. If ring arcs exist, the new moons might play an important role in "shepherding" and maintaining them, Voyager scientists said.

Prior to Voyager 2's discovery of the new moons, astronomers had knowledge of Triton, discovered in 1846 and Nereid, discovered in 1949. Triton is approximately 1,740 miles in diameter, while Neried is approximately 250 miles in diameter.

The Voyager Mission is conducted by the Jet Propulsion Laboratory, Pasadena, Calif., for NASA's Office of Space Science and Applications. ■

NASA Programs Generate More Than 300,000 Jobs, Study Shows

NASA activities generate more than 300,000 full-time jobs across all 50 states, according to a recent study undertaken for the agency by the NASA Alumni League. The study indicates that the money NASA spends for space and aeronautics research has a very significant impact on national employment, both direct and indirect.

The findings are based on a detailed study conducted for the Alumni League by Management Information Services, Inc. (MISI), Washington, D.C. Using conservative national economic models and examining only part of the NASA budget, the study predicts that some 237,000 jobs in private industry are generated by a NASA spending level of $11.3 billion. When the Alumni League expanded the scope to include the civil service work force, the support services required by NASA's field centers, and certain production and management operations not covered in the MISI study's economic model, the total increased to more than 300,000 jobs.

Copies of the study are available from the NASA Alumni League, 922 Pennsylvania Ave., S.E., Washington, D.C. 20003; phone 202/543-3587. ■

Pegasus– The Winged Workhorse

DARPA Announces First Payload

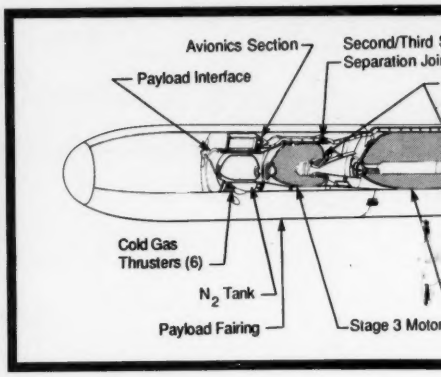
Artist's depiction of Pegasus' airborne launch from B-52 carrier aircraft.

Pegasus, mythology's flying horse, has provided an apt name for a new, airborne, winged launch system designed to boost small payloads to orbit.

Pegasus is a three-stage solid rocket booster, 49 feet-long and 50 inches in diameter, weighing approximately 41,000 pounds. Its delta wing spans 22 feet and it has three 5-foot span, movable control fins mounted on the first stage.

Developed by Orbital Sciences Corporation, Fairfax, Va., and Hercules Aerospace Corporation, Wilmington, Del., Pegasus is scheduled to orbit PEGSAT, a Goddard Space Flight Center developed multi-function payload, this fall.

Launched from a B-52 carrier aircraft operated by NASA's Ames-Dryden Flight Research Facility, Edwards, Calif., Pegasus' external



dimensions closely resemble those of the X-15 space plane originally launched from the B-52.

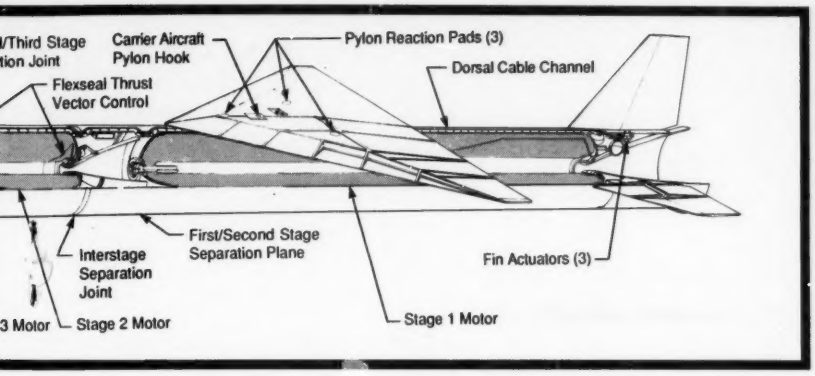
At 40,000 feet altitude and at a speed of Mach 0.8, launch is initiated and the Pegasus booster first stage motor ignites, its autonomous flight control system providing guidance through the flight.

A second stage boosts Pegasus to 104 miles altitude and over 12,100 miles per hour. The third stage motor then propels the booster into orbit at a velocity of over 17,000 miles per hour.

A number of aerodynamic payoffs are associated with the air-launched winged booster design. Most notable is the capability of placing more payload into orbit with less thrust than would be required if launching from a conventional ground-based booster. This is because dynamic pressures and structural stresses are much less on the booster when it is launched aloft. Lightweight, advanced composite materials can, therefore, be used to build the booster, allowing a proportionately larger share of the motor thrust to be used for lifting payload.

Moreover, the advanced composite material wings on Pegasus provides additional lift that designers say adds significantly to booster performance.

For this mission the B-52 will



launch the Pegasus at 40,000 feet altitude over the Western Test Range, carrying the 450-pound payload into a polar circular orbit of about 370 miles.

Also included in the Pegasus vehicle will be first-stage instrumentation, developed by NASA Ames-Dryden, to gather hypersonic flight performance data. The research data, acquired on a non-interference basis with the primary flight objective, is of broad applicability and will be used to validate the design and performance of the vehicle as well as the design methodology. Pegasus has a winged first-stage and provides a unique opportunity to study hypersonic airplane-like phenomena during flight. The method establishes a low-cost approach to hypersonic flight experimentation.

The PEGSAT payload will benefit both DARPA, the military services and NASA. It will provide DOD with the data needed to characterize the Pegasus payload environment, support small satellite experiments, and provide NASA with important space physics science and increase NASA's ability to design and build quickly inexpensive spacecraft of future space missions. ■

PEGSAT Payload

Includes:

- Launch Vehicle payload environment instrumentation measuring attitude, temperature, pressure, structural loading and vibration.
- Navy experimental communications relay satellite to determine ability of this class of satellite to meet a variety of meteorological and oceanographic research communications requirements.
- NASA series of barium chemical release experiments to study interaction of the chemicals with the magnetic and electric fields in the Earth's magnetosphere and ionosphere. Occurs 30 to 60 days after launch. Augments the reconfigured Combined Release and Radiation Effects Satellite planned for launch in the mid-1990 period and provides significant scientific results much earlier than planned, as well as valuable advanced experience prior to the mission.

Pegasus one-fourth scale model is displayed in front of B-52 carrier aircraft #008, operated by Ames-Dryden Flight Research Facility, Edwards, California.

EXTERNAL RELATIONS

NASA and German Ministry Sign Space Transportation Agreement

Richard H. Truly, NASA administrator, and Heinz Riesenhuber, Federal Minister for Research and Technology of the Federal Republic of Germany, have signed a memorandum of understanding enabling the launch of German payloads on the Space Shuttle.

This agreement confirms general understandings for the terms and conditions under which NASA will furnish launch and associated services on a reimbursable basis consistent with U.S. and German space policy. Under the MOU, specific launch services agreements or other agreements will be signed for each activity.

NASA Administrator Truly (right) and West Germany's Minister Riesenhuber sign Shuttle launch MOU.

The first flight will be the D-2 Spacelab mission, currently scheduled for launch in February 1992. It will carry German materials processing and life sciences experiments and a small number of NASA experiments. The crew will include two German payload specialists. The Federal Republic of Germany (FRG) has paid earnest money to NASA for an additional mission, the D-3 Spacelab, currently scheduled for launch in November 1993. ■

NASA, Canadians to Fly Plasma Experiment on OMV Mission

NASA is planning to fly a Canadian experiment to measure the behavior of radio waves in space and properties of the upper atmosphere, the ionosphere, during the demonstration flight of the Orbital Maneuvering Vehicle (OMV), according to a proposal recently agreed to by the Canadian Space Agency.

The maiden voyage of the OMV, a remotely controlled, reusable "space tug" designed to perform a number of tasks including maneuvering other spacecraft on orbit, is currently scheduled for launch aboard the Space Shuttle Endeavour in 1993. Its payload will be a 3-part, high-frequency radio wave experiment called Waves in Space Plasma (WISP-HF).

Developed by the National Research Council of Canada, the experiment will measure the interaction of an antenna with the tenuous upper atmosphere that has been transformed into a plasma — a gas of charged particles — by sunlight. ■

U.S./USSR Earth Sciences Group Identify Co-op Areas

Meeting in Washington, the U.S./USSR Joint Working Group on Earth Sciences has agreed to cooperate in two sub-satellite experiments related to land-atmosphere interactions, outlined plans for a joint research program in volcanology and agreed to cooperate in studies of changes in the Earth's cryosphere in response to global climate warming.

The two sub-satellite experiments call for nine Soviet scientists to provide ground-based and airborne experiments and to participate in the U.S. first field experiment in the International Satellite Land Surface Climatology Project in Kansas during the summer of 1989.

Ten U.S. scientists will provide experiments and participate in a similar experiment near Kursk in the USSR in 1991. The experiments will include the exchange of satellite data on these sites.

The joint research program in volcanology includes a prospective joint field verification campaign in Kamchatka, USSR, in 1990 and a subsequent campaign in comparable U.S. volcanic research sites. A measurement campaign using airborne, satellite and ground-based techniques could follow.

A cooperative project to study changes that are occurring in the Earth's cryosphere in response to global climate warming was initiated with the participation of the U.S. Geological Survey, NASA's Goddard Space Flight Center, Greenbelt, Md., and the Institute of Geography of the USSR Academy of Sciences. The two sides will prepare experimental maps, compiled from satellite remote sensing imagery, to document changes that have occurred and are occurring in the coastal regions of Antarctica. ■

CENTER HIGHLIGHTS

Marshall Scientists Identify Molecular Structure of Blood Protein

By John Dumoulin, MSFC

Scientists at NASA's Marshall Space Flight Center, Huntsville, Ala., have solved a mystery that may help in the design of new or improved disease-fighting drugs.

Using a technique known as X-ray crystallography, a team of scientists and technicians, headed by Dr. Daniel C. Carter, has successfully determined the three-dimensional structure of human serum albumin, the most abundant plasma protein in the human circulatory system. Knowing the molecule's structure may allow pharmaceutical companies to design new drugs or alter existing drugs to allow them to be more efficiently carried by the protein molecule through the body.

Compiling the images of hundreds of individual X-ray diffraction experiments, Carter of the Marshall Center's Space Science Laboratory, and colleague Dr. Xiao-min He, Universities Space Research Association (USRA), identified the plasma protein as a large, ellipsoidal molecule of six bundles of intertwining spirals of amino acids. USRA is headquartered in Columbia, Md.; Dr. He works at USRA's Huntsville, Ala., office.

The scientists have successfully mapped and confirmed the structure of the protein to a resolution of six angstroms, providing an image with enough detail to extract data about individual molecules. The scientists' next step will be to further refine the resolution to three angstroms using space-grown crystals. This higher resolution will help identify individual spirals in each bundle of the molecule, a process that may take one to two years.

Human serum albumin crystals have been grown twice in space, most recently during Shuttle mission STS-26 last September as part of a Marshall-managed protein crystal growth experiment.

Identifying the structure of human serum albumin has been the goal of crystallographic investigations for many years. Many studies have focused on the protein's ability to bind to other substances.

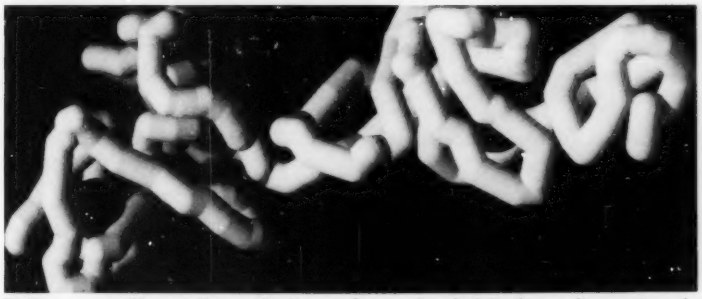
"We knew that the protein binds and transports a wide variety of substrates in plasma, such as calcium, copper, fatty and amino acids, hormones and an impressive spectrum of therapeutic drugs," said Carter. "Now, knowing the structure, we can determine where on the molecule these substrates bind. For instance, preliminary binding studies of several compounds, including common aspirin, have shown that many compounds are transported inside just two of the molecule's segments, or bundles: the first and fifth."

Many existing drugs are now less effective or entirely ineffective because their molecular structures either fail to bind or bind too tightly with the protein, said Carter. The metabolism, distribution and effectiveness of many pharmaceuticals can be significantly altered based on their affinity for human serum albumin.

Therefore, scientists believe the knowledge of the three-dimensional structure, and how and where the substrates bind on the molecule, may significantly change the industry's approach to drug design.

"Most of the hard work is behind us," said Carter. "Now that we know how to obtain this resolution, it's a matter of systematically refining the details. But scientists will be studying applications for the protein molecule for a long time."

In addition to Carter and He, other members of the science team included Teresa Y. Miller, Marshall Space Flight Center, and Sibyl H. Munson, Pamela D. Twigg, Kim M. Gernert and M. Beth Broom, all under contract with USRA, a non-profit consortium of universities involved in space science research. ■



X-Ray crystallography techniques determined this three-dimensional computer illustrated configuration of the molecule Human Serum Albumin, the most abundant protein in the circulatory system.

Goddard Opens Space Robotics Lab

By Michael Braukus, GSFC

Goddard Space Flight Center, Greenbelt, Md., has opened its new state-of-the-art robotics facility.

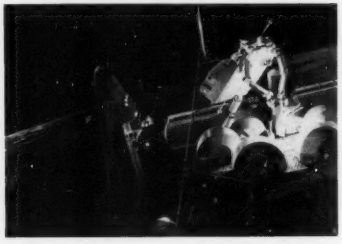
Goddard's robotics team will use the highly sophisticated lab to create, test and evaluate new robotic technologies to support Space Station Freedom.

As part of the Freedom project, Goddard manages the development of the Flight Telerobotic Servicer (FTS), a robotic device that combines teleoperation — the using of a human operator to direct the machine — and autonomous capabilities for performing tasks by itself but supervised by an astronaut. Martin Marietta Space Systems Co., Denver, Colo., will develop the FTS.

Said Ronald Browning, Goddard's deputy director for Space Station Freedom, "FTS is designed to complement astronaut extravehicular activity and will be used both with and without a crewman."

The new facility contains a gantry robot 40 feet wide, 60 feet long and 20 feet high with six degrees of freedom, capable of lifting up to two tons of payload and applying 4000 foot- pounds of torque.

Suspended from one mast of the gantry will be a set of teleoperated industrial arms, which will be used as an FTS operational simulator. Another mast carries a grapple to emulate Freedom's remote manipulator system, which primarily will be used to transport payloads to and from the work site.



Flight Telerobotic Servicer repairs Space Station Freedom in this artist's concept.

The facility also includes an operator work station installed in a mockup of the Space Shuttle's aft flight deck. This simulator will permit teleoperation of the robot, providing valuable information about operating the FTS in the constrained environment of the Shuttle.

Located in a glass enclosed mezzanine, overlooking the gantry robot, is the Graphic Robot Simulator.

This computerized simulator uses animated graphics to determine such things as the robot's reach capability and collision avoidance information. ■

Langley Studies Heavy Rain Effects on Aircraft Performance –May Be Reduced When Most Needed

By H. Keith Henry, LARC

Preliminary results from a series of high-speed ground tests indicate that heavy rain may reduce aircraft wing performance when it is most needed, during landing approach or take-off in the presence of a microburst storm, according to researchers at NASA's Langley Research Center, Hampton, Va.

A survey of commercial aircraft accidents and incidents related to severe storms prompted NASA to study the possibility of a heavy rain effect on aircraft safety and performance. Heavy rain is generally defined as a high-intensity, short-duration rainfall.

Modern wings on commercial aircraft, optimized for economy, rely on a smooth, uninterrupted flow of air across the wing surfaces for maximum performance. Tests suggest that very heavy rain disrupts the airflow, reducing wing lift and performance.

The heavy rain research is part of a broad NASA-Federal Aviation Administration airborne wind shear detection and avoidance program begun in 1986.

In cases where greater than usual wing lift is required, as in a low-altitude encounter with wind shear, heavy rain may reduce wing performance when it is most needed. In fact, a series of small-scale wind tunnel tests in the mid-1980's suggested that there is a heavy rain effect at extremely high rain rates. Wing lift losses of greater than 20 percent were observed.

To test in more realistic conditions, the program was extended to the present high-speed, large scale ground tests. Results after the first 20 runs tend to verify the wind tunnel tests.

During the next phase of the program, the project team plans to change the rain rate to determine at what point heavy rain begins to affect wing performance.

The key question being addressed — are heavy rain effects a potential concern even at light or moderate rain rates or is it something to consider only in the most intense downpours. The answer is important to help define the seriousness of the problem. If heavy rain effects prove to be significant under realistic flight conditions, it follows that piloting procedures need to be changed to take these effects into account according to researchers. ■

Q&A

The following questions and answers are excerpted from interviews conducted for NASA's radio program, "The Space Story".

School Days for Astronauts!

At this time of year, most students are involved with their return to school. But NASA astronauts go to school all year round. In fact, maybe for several years before their ultimate test — an actual Space Shuttle mission. Whether the astronauts are commanders, pilots, mission specialists or payload specialists, all must do some similar training at the NASA Johnson Space Center in Houston, Texas.

Q What can an astronaut learn in NASA KC-135 "classroom"?

A Kathy Daues, a systems engineer in the aircraft operations division answers: "They all have the opportunity to just ride on the aircraft and feel it so they know what that experience is like and also to practice functions in zero-g depending on what the function is they'll do in their mission. . .They use it for so many things. It can be used for astronauts to practice donning and doffing an EVA suit in zero gravity. . .and it's also used to verify that equipment works in zero-gravity. It climbs to a very high altitude steep angle, and rolls over and comes down like a roller coaster at an equally steep angle, and while you go over the top and you get freefall, you get your thirty seconds of weightlessness.

Q Aside from zero-gravity preparation, are other aircraft used to prepare astronauts for space flight operations?

Three JSC T-38s fly formation high over southern Texas. These "classrooms" in the sky allow astronauts to maintain flight proficiency in preparation for Space Shuttle flights.

A The 2-seat T-38 jet trainer assists astronauts in maintaining space flight readiness. Ms. Daues explains: "They ... use them to maintain their flying skills and...they're required to fly a certain number of hours a month. A mission specialist is also required to have a certain number of backseat hours." The T-38 can also give future crew members an idea of shuttle approaches to the landing strip.

But another method provides a more realistic landing experience. The shuttle training aircraft, or S-T-A, is a modified airplane whose cockpit resembles the shuttle's own, having the same controls and displays. Student pilots can give "shuttle-like" inputs and the aircraft and the aircraft responds just as the orbiter would. "We basically take the aircraft to 20,000 feet or so. . .and in less than 3 minutes we are down to shuttle landing altitude and right at about 190 knots. . . The astronauts tell us, once they have done a real flight, that it's identical and it is the best training they've had, basically." ■

Columbia continued from page 6

Five major modifications made at Palmdale, Calif., included: (1) structural strengthening of the wings and mid-fuselage; (2) addition of a heads-up-display; (3) the replacement of the commander and pilot's ejection seats with standard seats; (4) modification of the orbital maneuvering system pods to make them compatible with the other orbiters and (5) addition of supplemental instrumentation to gather developmental engineering data.

An infrared imaging device on Columbia's vertical stabilizer, Shuttle Infrared Leeside Temperature Sensing (SILTS) experiment is designed to obtain high-resolution infrared images of the upper (leeside) surfaces of Columbia's port wing and fuselage as the orbiter reenters Earth's atmosphere.

The Shuttle Entry Air Data System (SEADS), housed in the nosecap provides aerodynamic flight characteristics by measuring local surface air pressure during reentry.

Other improvements include upgrades to the electrical system, upgraded cockpit computer keyboards, new fuel cells and new auxiliary power unit controllers and a newly modified liquid hydrogen recirculation pump package. ■

NASA NEWS CAPSULES

News Capsules are NASA news releases edited by the Internal Communications Branch, Office of Communications.

NASA Selects Science Experiments for Microgravity Missions

NASA's Office of Space Science and Applications, has selected 23 scientific investigations and their principal investigators for definition studies which could lead to Space Shuttle flights on microgravity science missions. The definition phase is expected to last up to two years prior to the proposed flight for a particular investigator.

The 23 investigations come from 19 institutions, all within the United States. Three of the institutions are NASA centers — Jet Propulsion Laboratory, Pasadena, Calif.; Marshall Space Flight Center, Huntsville, Ala.; and Lewis Research Center, Cleveland. Eleven institutions are universities.

Of the 23 investigators selected, 15 were selected for materials science, five for fluid dynamics experiments and three for biotechnology investigations. Experiments would fly aboard Shuttle microgravity missions in two series — the U.S. Microgravity Laboratory (USML) and U.S. Microgravity Pallet (USMP) series and the International Microgravity Laboratory (IML) series.

The IML-1 is scheduled for launch in December 1990. The USML-1, scheduled for launch in March 1992, would be the first mission to use the extended duration orbiter. ■

University Advanced Engineering Design Grants

NASA has selected 36 universities as recipients of 3-year grants to design advanced aeronautics and space mission concepts as topics for senior engineering design courses.

The University Advanced Design Program grant recipients will study topics in space and aeronautics missions, in the post-Space Station era, such as manned Mars aircraft and delivery system, long-term space habitat, lunar launch and landing facilities and operations and trans-Pacific, high-speed civil transport.

The unique NASA program is managed by the Universities Space Research Association (USRA), Houston. ■

Hubble Space Telescope Observations Selected

The Space Telescope Science Institute, Baltimore, Md., has completed selection of the first science observation proposals from the astronomy community to be carried out using the NASA/European Space Agency (ESA) Hubble Space Telescope.

The Hubble Space Telescope (HST), scheduled for launch in March 1990, is the first major international optical telescope to be permanently stationed in low-Earth orbit. Capable of viewing the universe with a tenfold greater resolution than ground based observatories, the HST has a tremendous potential for fundamental scientific breakthroughs in astronomy.

Among the accepted proposals are plans to search for black holes in neighboring galaxies, to survey the dense cores of globular star clusters, to better see the most distant galaxies in the universe, to probe the mysterious core of the Milky Way galaxy and to search for neutron stars that may trigger bizarre gamma-ray bursts.

The 162 proposals were accepted following an intensive scientific peer review of 556 proposals submitted by astronomers from 30 countries. ■

Space Station Experiments Selected

Flight experiments, or concept studies leading to experiments, that will fly aboard the Space Station Freedom have been announced by the Office of Space Science and Applications.

The Office of Space Science and Applications has selected these 27 experiments which fall into two categories. The flight category is for attached scientific experiments that can be mounted aboard elements of Freedom's structure during its assembly and outfitting phase. The 14 investigations selected in this category will be the first performed aboard Freedom. Flight proposals were solicited that would be limited in weight and make only modest demands on station resources, such as power, cooling and crew availability, during the busy assembly phase.

The concept study category is for studies that may lead to flight experiments after the assembly phase. These proposals were solicited for more advanced ideas that could be implemented after station assembly when additional resources, such as higher power and data-handling capabilities, will be available. ■

HUMAN FACTORS

O'Brien Returns to NASA as Assistant Deputy Administrator

NASA Administrator Richard H. Truly has announced the return of John E. O'Brien to NASA as assistant deputy administrator, NASA Headquarters, effective July 30.

In this position, O'Brien will support the agency's efforts in formulating plans to implement future goals in space as outlined by President Bush in his July 20 speech. Also, he will perform special analyses for the administrator and be involved in management problem solving.

O'Brien returns to NASA from the Washington law firm of Steptoe & Johnson where he specialized in defense and aerospace legal issues. He previously served as NASA general counsel from August 1985 to July 1988 after serving as deputy general counsel since November 1981.

He joined NASA in 1962 as staff attorney at NASA's Launch Operations Center, now the Kennedy Space Center. Prior to that position, he had served as staff attorney at the Navy General Counsel's Office in Washington, D.C., from 1957 to 1962. In 1970, he was appointed Chief Counsel of the Kennedy Space Center and NASA Assistant general counsel for Procurement Matters in 1973. ■

Ballhaus Resigns as Ames Director

Dr. William F. Ballhaus, Jr., has resigned as Director of NASA's Ames Research Center, Mountain View, Calif.

Ballhaus served as Director of the center from January 1984 through January 1988 and from February 1989 until the present.

Ballhaus also served as Acting Associate Administrator for Aeronautics and Space Technology, NASA Headquarters, Washington, D.C., from February 1988 through March 1989. In this temporary position, he was responsible for direction of NASA's aeronautics and space technology programs, as well as the institutional management of NASA's Ames, Langley and Lewis research centers.

Citing inadequate compensation for senior federal executives and vague new post-government employment regulations as factors in his decision, Ballhaus expressed regret at leaving federal service. ■

Force Named to Head Space Operations, Aller Leaves Civil Service

Force

Aller

NASA Administrator Richard H. Truly has announced the appointment of Charles T. Force to head the Office of Space Operations. He succeeds Robert O. Aller who left the agency and government service July 14, 1989.

Force was appointed the deputy associate administrator for Space Tracking and Data Systems in September 1986. He spent 10 years in private industry before joining NASA in 1965. Force has considerable accomplishments in the development, operation and management of NASA's global networks that provide tracking and communications support for NASA missions. Prior to becoming Deputy Associate Administrator, he held several senior level positions at NASA including two overseas assignments.

Aller was named associate administrator of the Office of Space Operations (OSO) on Jan. 9, 1987. During his tenure, he oversaw the completion of the Tracking and Data Relay Satellite System (TDRSS). The three-spacecraft system became fully operational following the successful deployment and check-out of TDRS-3 and TDRS-4, launched aboard the Space Shuttle in September 1988 and March 1989, respectively. The space-based TDRSS network permits almost continuous communications with the Space Shuttle and other low-Earth orbiting spacecraft.

Aller served as Associate Administrator for the Office of Space Tracking and Data Systems, predecessor to OSO, from November 1983 to January 1987.

Citing many disappointments in the treatment of government employees, Aller accelerated his departure because of the vague new-post government employee regulations. "NASA has produced this nation's most exciting programs and it is my belief we are on the threshold of a decade of intense worldwide space activities, with the United States being the leader in discovery, exploration and utilization", he said. ■

Lee Appointed Marshall Director

NASA Administrator Richard H. Truly has announced the appointment of Thomas J. (Jack) Lee to be Director of the Marshall Space Flight Center, Huntsville, Ala. Lee succeeds James R. Thompson, Jr., who was selected by President Bush to be the NASA Deputy Administrator.

Lee was Marshall's Deputy Director since December 1980, following seven years as manager of the Spacelab program at the center. From July to September 1986, he served as Acting Director of the center.

In addition to his responsibilities as Deputy Director, Lee has served as Manager of the Heavy Lift Launch Vehicle Definition Office, which is leading NASA's efforts to define and develop a heavy lift launch vehicle capable of meeting national requirements.

As Marshall Center Director, Lee is charged with overall management of one of the largest and most diversified of the NASA field centers. The center, with 3,500 employees, has responsibility for the design and development of space transportation systems, orbital systems, scientific and applications payloads, and other projects for present and future space exploration, research and commercial developments. ■

Couch Receives WIA Award

Lana Couch, acting director for space, Office of Aeronautics and Space Technology (OAST), has received the Women in Aeronautics (WIA) "Carrying the Fire Award." The award honors individuals who have persisted in keeping alive national and global interest in human exploration of the solar system. Couch was chosen for her career-long technology developments at NASA.

Couch began her career with NASA at the Langley Research Center in 1963, conducting research in the fluid flow phenomena on subsonic through hypersonic aircraft and launch vehicles. She was selected as head of the Structural Tunnels Section in 1975 and assistant head of the Thermal Structures Branch in 1979.

Following completion of the Maxwell Midcareer Development Fellowship at Syracuse University and an assignment as deputy OAST facilities manager under NASA's Critical Assignment Development program, she was selected in 1982 as the Aerothermodynamics Program manager in OAST's Fluid and Thermal Physics Office at NASA Headquarters.

In 1983, she served as acting manager of the Spacecraft Systems Office, was subsequently named deputy director of the Flight Projects Division, and was then appointed director of NASA's National Aero-Space Plane program. Following approval and initiation of the Aero-Space Plane Program, she joined Senator Donald W. Reigle's staff in March 1987 as a congressional fellow with the Commerce, Science, and Transportation Committee. ■

Tanner Departs NASA, Sisson Named Acting Deputy Director for Space Station

E. Ray Tanner, deputy director, Space Station Freedom Program and Operations, retired from NASA effective July 15, 1989.

Dr. William B. Lenoir, associate administrator for Space Station named Jim Sisson as acting deputy director. Sisson currently serves as deputy program manager for the Space Station Freedom Program Office, a position he has held since November 1986.

Prior to coming to NASA Headquarters, Sisson held key management posts at the Marshall Space Flight Center, where he was for 24 years.

Tanner came to the Washington area last December to head the Space Station Freedom Program Office in Reston, Va. Prior to that, Tanner was manager of the Space Station Projects Office at the Marshall Center. ■

Since the beginning of space travel, astronauts have taken onboard with them items of personal sentiment. For STS-30 mission specialist Mark C. Lee, a picture of a cow testifies to his background as one reared on a Wisconsin farm. Moooooooo!